

REVIEW/RESEARCH ARTICLE/SHORT COMMUNICATION

Energy Scarcity and National Defense Challenges

Bagus Bramantio¹, Pantja Djati², Siswo H. Sumantri³, Suyono Thamrin⁴, Herlina Juni Risma S⁵

^{1,2,3,4,5} Defense Science Doctoral Program, University of Indonesia Defense

Email: bagusbramantio@gmail.com/bagus.bramantio@idu.ac.id¹, spantjadjati@gmail.com², siswo_32@yahoo.com³, suyono.thamrin@gmail.com⁴, and herlina.saragih@idu.ac.id⁵

Submitted: 01.01.2020; Accepted: 01.01.2020

Abstract

Energy is a very important component and can be a threat (military and non-military) within a country, so the defense of country can be supported by national energy security. Currently, Indonesia experiences the supply of fossil energy has decreased very significantly. According to the 2019 Indonesian Energy Outlook, it explains that Indonesia's fuel demand is 1.6 million barrels, despite the fact that domestic oil production is approximately 760 thousand barrels, and refinery capacity reaches 1.1 million barrels, so it still needs to import 340 thousand barrels of oil and 500 - 600 thousand barrels of fuel to meet Indonesia's demands. Regarding that, one day Indonesia will experience a shortage of energy. This journal uses a literature study research method and gathers information from competent parties about energy scarcity and national defense challenges. From the results, energy scarcity must be immediately addressed. The right strategy to overcome energy scarcity requires alternative energy, namely NRE where Indonesia has enormous potential, i.e., geothermal energy. Geothermal energy in Indonesia has installed capacity of GPP, but only 8.9% of 2,130.7 MW potential resources. By looking at the large potential of geothermal, it can be a base load in electricity, however it requires supporting regulation to encourage the exploitation.

Keywords: New and Renewable Energy, Energy Security, National Resilience, Geothermal

1. Introduction

A country will not be free from a threat, and threats include military threats, non-military threats and hybrid threats. One of the future threats to occur in Indonesia is the non-military threat, namely the occurrence of energy scarcity, this is because Indonesia is still using fossil fuels to support national energy security. If energy scarcity occurs in a very long period of time, this will cause an energy emergency phenomenon to occur. Energy itself is one of the important factors supporting national defense. In Law no. 30 of 2007 concerning energy, energy emergency is a condition of disruption of energy supply due to disconnection of energy infrastructure. Energy is also one of the supporting factors for national defense. Energy is a very vital component, energy itself can make a non-military and military threat if this energy is scarce resulting in conflict in the struggle for energy. In the SKK Migas annual report (2018) on the 2019 BPPT Energy Outlook, oil and gas reserves in 2018 have decreased [1].

To accomplish stronger national energy security in the future, it is required to have an energy management policy that favors increasing energy independence through the principles of good governance (Good Governance Principles) which are expected to be well integrated, able to anticipate opportunities and the challenges ahead, ensure sustainability, protect consumers who have low purchasing power, and improve people's welfare. Energy policy is also intended to regulate relations between agencies related to energy through the roles of the Government, Local Government and the community. In addition, it also regulates energy pricing, subsidies, research and development, improving the quality of human resources, energy planning, international cooperation, emergencies and energy crisis, buffer reserves, as well as cross-sectoral energy guidance and supervision.

Oil reserves decreased 0.27% against 2017 or 7.51 billion barrels and natural gas decreased 5.02% compared to 2017[2]. One of the causes of reduced oil reserves is an increase in demand for supply of fossil energy needs every year. This is because energy needs are currently still dominated by fossil energy. Energy demand

in Indonesia itself has also experienced an increase in demand every year. However, non-renewable energy supplies (fossil) including petroleum, natural gas, and coal are running low. According to Strategic Plan (Renstra) of the Ministry of Energy and Mineral Resources for 2015– 2019, Indonesia's oil reserves of 3.6 billion barrels are expected to be depleted in the next 13 years. Currently in Indonesia, oil production is decreasing, the cause is the decreasing production of wells. In 2018 the government was targeting production of 800 thousand barrels per day, but until the end of July 2018, data from the Ministry of Energy and Mineral Resources shows that the average oil production remains around 773 thousand barrels per day. The amount of production is far less than in 2015, when it was 949 thousand barrels per day.

The rate of discovery of new reserves must be supported by technological advances for exploration and exploitation efforts that are still constraining. The need for fuel oil in Indonesia continues to increase in line with the increasing population and economic activities. According to the 2019 Indonesian Energy Outlook, the transportation sector consumes the most energy at 40%, followed by the industrial sector at 36%, households at 16% and the commercial sector at 6% and other sectors at 2%. Indonesia has 1.6 million barrels of fuel needs, and yet domestic petroleum production is now only 760 thousand barrels, with a refinery capacity of 1.1 million barrels, so it still needs to import 340 thousand barrels of oil and 500 thousand - 600 thousand fuel oil barrels to meet Indonesia's needs. It is essential to identify alternate fuel-producing sources to lessen reliance on petroleum and fuel oil imports. [3].

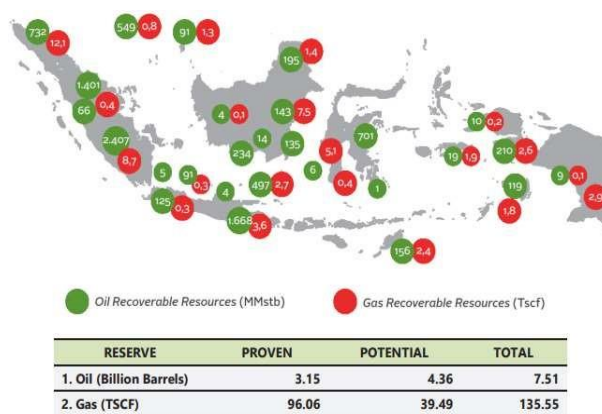


Fig. 1. Oil and Gas Distribution Map. Source: Nugroho, 2014.

Indonesia is still facing various problems in achieving its development targets in the energy sector to date. Dependence on fossil energy, especially petroleum, in meeting domestic energy consumption is still high. The subsidy policy which results in cheap energy prices and people tends to be wasteful in using energy, leading to high consumption of fossil energy[4]. On the other hand, the continuing decline in Indonesia's fossil energy reserves has not been matched by the discovery of new reserves. The available energy infrastructure is still limited, thus limiting people's access to energy. This makes Indonesia vulnerable to disruptions in the global energy market because part of its energy consumption, especially petroleum products, is met from imports. Seeing this phenomenon is one of the reasons that Indonesia will experience an energy crisis, in the current situation relying on fossil energy alone to maintain national energy security is not possible. By looking at the conditions that have occurred at this time, it shows that in the future Indonesia will have the potential to become an oil importer. Seeing the condition of fossil energy supply has decreased capacity and the time is right for Indonesia to use alternative energy or renewable energy in meeting national energy security

Fossil energy which is continuously exploited cannot be renewed in a fast time, but requires natural processes for thousands of years. Ensuring the availability of energy is an important element in ensuring national

resilience. National resilience is a country's resilience and durability, which includes the ability to grow national strength in the face of any threats, both external and internal, that directly or indirectly jeopardize the nation's and state's existence. In the Book of Indonesian Defense White Paper (Buku Putih Pertahanan Indonesia), food, water and energy security are important elements in ensuring national resilience[5].

The current limitations of fossil energy in the world and for the country of Indonesia, when viewed from the energy security indicators, are known as 4A + 1S, namely Availability, Accessibility, Affordability, Acceptability, and Sustainability, facing an energy crisis in which availability is dwindling and must be supported by technological advances, as well as the impact of the use of fossil energy which affects the environment and climate. The threat of this energy crisis is the basis for the United Nations (UN) to change its mindset to switch by using renewable energy sources known as renewable energy sources[6].

Indonesia has abundant potential new and renewable energy sources but has not been optimally utilized due to several constraints such as high investment and geographic location[7]. The potential for new and renewable energy sources can support Indonesia's role in Presidential Decree No.59 of 2017 concerning the Implementation of Achieving the Sustainable Development Purposes in point 7, namely Clean and Affordable Energy. Achievements made by the government through several indicators, including electrification ratio, electricity consumption per capita, urban gas network, new and renewable energy mix, and primary energy intensity[8].

Table 1. 2020 NRE Power Plant Capacity and 2021 Target

Jenis EBT	2015	2016	2017	2018	2019	20200
Hybrid	3,6	3,6	3,6	3,6	3,6	3,6
Bayu	1,5	1,5	1,5	143,5	154,3	154,3
Surya	33,4	43,1	50,9	67,8	136,6	153,4
	1.741,7	1.783,1	1.856,8	1.882,8	1.889,8	1.903,5
Bioenergi						
Panas Bumi	1.438,3	1.533,3	1.808,3	1.948,3	2.130,7	2.130,7
Air	5.277,5	5.620,9	5.657,9	5.742,1	5.976,0	6.121

Source: ESDM, 2020

Overall, Indonesia has enormous potential in the development of new and renewable energy, one of which we will discuss in this journal is renewable energy, namely geothermal energy. Indonesia has the largest geothermal energy potential in the world, with the least 23.9 GW total geothermal potential. Of this amount, only 2.1 GW has been utilized. The National Energy Policy has targeted that geothermal can support 5% of the national energy mix by 2025, but until now geothermal has only contributed 1% with slow development. Therefore, a solution is needed to overcome the energy emergency that is currently happening in Indonesia, and this energy emergency condition will also affect the condition of the national defense strategy. If utilized properly, the potential for new and renewable energy in Indonesia can contribute to providing a source of electrical energy.

Renewable energy in Indonesia, one of which is geothermal energy (geothermal), is energy that is friendly to the environment, has great potential, and is a source of renewable energy. As an energy substitute for fossil fuel energy, utilization of geothermal energy can also reduce CO₂ emissions into the atmosphere. Indonesia is a country that is bestowed with the potential for abundant geothermal energy, around 40% of the world's reserves of geothermal energy resources, from the potential owned as much as 2,130.7 MW in 2019 or only around 8.8% are utilized (Ministry of Energy and Mineral Resources, 2021) of the existing potential. As for the National Energy General Plan (RUEN), the share of the energy mix in 2025 for EBT is targeted at 23% and increases the contribution to 45 GW (equivalent to 69.2 Mtoe) of generator EBT-based electricity by 2025.

Table 2. Potential and Utilization New and Renewable Energy in Indonesia

Jenis Energi Terbarukan	Potensi	Pemanfaatan
Samudera	17,9 Gw	0 MW (0%)
Panas Bumi	23,9 GW	2.130,7 MW (8,8%)
Bioenergi	32,6 GW	1.905,3 MW(5,8%)
Bayu	60,6 GW	154,3 MW (0,25%)
Hidro	75 GW	6.121 MW (8,2%)
Surya	207,8 GW	153,5 MWp (0,07)
TOTAL	417,8 GW	10,4 GW (2,5%)

Source: ESDM, 2020

Table 2 explains that Indonesia has enormous new and renewable energy potential as an alternative energy substitute for fossil energy. The potential of new renewable energy is currently at 417.8 GW, while those that have been utilized for now are 10.4 GW. The potential and users of new and renewable energy that have optimal development are hydro and geothermal renewable energy. Hydro renewable energy has a potential of 75 GW and 6,121 MW or 8.2% of the potential for hydro renewable energy has been utilized. And the second is geothermal power which has a potential of 23.9 GW and has been utilized for 2,130.7 MW or 8.8% of the potential for geothermal renewable energy has been utilized. Table 2 shows that geothermal energy in Indonesia is more widely used or explored. Geothermal energy will also be used as an alternative energy substitute for fossils. Therefore, this journal article will discuss the utilization and prospects of geothermal energy as an alternative energy substitute for fossil in order to support national energy security.

2. Theory and formula

In this study, precipitation data of Bangladesh were obtained from This research was conducted using a qualitative descriptive research method. The data used in this study were taken through in-depth interviews with an expert and literature study from various relevant sources[9]. Library studies are efforts made by researchers to obtain various information, according to the topic being researched, namely by digging up various information that comes from scientific books, research reports, scientific essays, theses and dissertations, regulations, and other sources both in writing and from electronic media [10]

The purpose of this literature study is to explain the variables that are the topic of research. This study also conducted a comparison of literature studies in which, this literature study was made to obtain predictions from previous journal data to find out how much potential the development of new energy is available for geothermal energy in Indonesia. The literature used in this article includes, among others, official government sources, in the form of documents, statements and releases that can be accessed by the public. This article is then also supported by using other sources such as news, documents and statements obtained from other sources if they are judged to have a suitability with the context discussed in this article.

3. Result discussions

3.1. Relationship between State Defense and Energy Security

Law No.3 of 2002 Chapter 3 article 7 on the Implementation of State Defense explains that the National Defense system in facing military threats is carried out by the Indonesian national army (TNI) as the main component (military defense) supported by the reserve and supporting components in carrying out War Military Operations (OMP) (RI Law No.3 of 2002). In line with this, national resilience is interpreted as the resilience of the nation and state in facing multidimensional challenges in the agenda of their national interests. In general, there are eight elements that support the achievement of Indonesia's national resilience in the description of the National Resilience Astagatra which includes aspects of geography, natural wealth, demographics, ideology, politics, economy, socio-culture and defense and security. Indonesia's national resilience faces challenges both internally and externally, the current challenge is about energy supply. Basically national resilience is also influenced by energy security and very crucial because of its very important role in the fields of politics and government, economy, social life, and the defense and security of a country. Thus energy security is often described as the foundation of national resilience[11]. And in Law no. 23 of 2019 concerning the management of National Resources for national defense[12], which from this Law shows that energy, including national resources and energy, plays an important role in national defense.

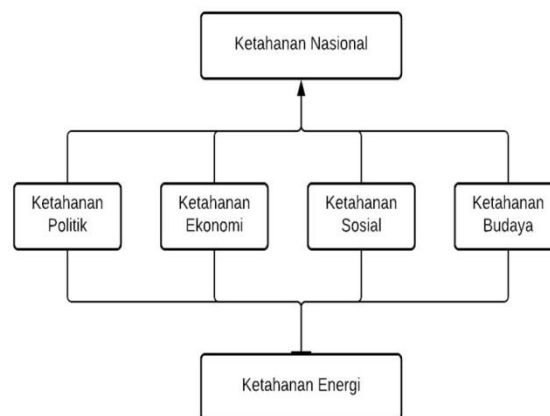


Fig. 2. The Role of Energy in National Resilience. Source: Hakim, 2015.

Energy security itself has a significant relationship with national resilience, in Law NO. 30 of 2007 on energy explains that energy has a very important role, energy has a role in increasing economic activities and national activities [13]. In general, there are four main principles that can guarantee a country's energy security, namely[11]:

- There is a dual effect of energy diversification, on the one hand diversification of supply (type and origin of energy sources) and on the other hand diversification of economic activities in the domestic economic system through the development of alternative energy sources. Here will be seen whether the country can reduce the share of oil in economic activity as a whole or not.
- There is resilience, namely by providing strategic reserves that are ready to use in situations of supply disruption.
- The recognition of the reality of integration and the truth of the world oil market and the development of energy security comes from market stability.
- The existence of building the power of information with databases that have high accuracy and delivered at the right time.

Energy is a basic human ingredient for advancing towards the development of world civilization and economy that will change the pattern of human life and relations between countries. The existence of energy is very crucial because of its very important role in the wheels of politics and government, the economy, social life, and the defense and security of a country. Therefore, energy security is often described as the foundation of national resilience. Energy security itself occurs because of the factors of national resilience. National resilience is a dynamic condition, in which a nation contains tenacity and durability to be able to develop resilience, national strength in facing threats, challenges, obstacles, disturbances from within and outside the country, directly or indirectly endangering its integrity[4]. Energy security itself is in accordance with PP KEN No. 79 of 2014 is a condition that guarantees the availability of energy, people's access to energy at affordable prices in the long term while still paying attention to the protection of the environment[14].

Energy is a supporting factor for national defense, one of which can be seen in the state expenditure budget, especially for defense alusista. Whereas for the use of alusista in the Ministry of Defense, most of them still use fossil energy. It can be seen in Figure 3 that in 2020 the expenditure budget for the energy needs of the Ministry of Defense has increased. National energy security is also influenced by the strategic environment both from within (internal) and outside the country (externally). Internal factors include economic growth, energy consumption, and the availability of adequate energy infrastructure. Meanwhile, external factors include the maintenance of energy price stability within the country as a response to the dynamics occurring in international energy prices.



Fig. 3. Budget for Energy Expenditure Ministry of Defense. Source: Ministry of Defense, 2020.

Seeing the increase in the Ministry of Defense's budget regarding the state budget for the energy sector shows that energy is one of the supporters of national resilience. The concept of Energy and Defense is related to one another because in carrying out national defense activities, the maintained energy supply really supports the creation of a safe atmosphere, especially in border areas. Not only that, the energy supply that is available and accessible to people in border areas also plays a role in maintaining the sovereignty of the country because it avoids any intervention from outside countries because people in border areas feel cared for. On the other hand, the defense sector plays a role in safeguarding the energy source which is a vital national object from threats from outside countries trying to take over the region.

3.2. Development of Geothermal Energy in Indonesia

Alternative energy can be used as a substitute for fossil energy in Indonesia. This fossil energy is increasingly limited, both in quantity and in reserves. Even this problem will become a problem in the future, because the substitute energy from fossil energy which is said to be alternative energy in 2025 is predicted not to be able to meet national energy needs in the future. The role of energy is so strategic that a country that has a lot of energy stores a lot of energy reserves will rule the world. So Indonesia must not remain silent in providing domestic energy needs and looking for alternative energy sources for the prosperity of the nation and the State as mandated by the 1945 Constitution.

Geothermal is a form of renewable energy that produces minimal greenhouse gas emissions and can provide energy stability and security. Geothermal energy can be a real solution for the wider community who need electricity in the future. Geothermal energy can also contribute to community energy independence in remote villages as well as to protect rural communities against high petroleum prices[15]. Geothermal energy can also facilitate economic opportunities in providing energy for alternative uses such as food production. Geothermal plays an increasingly important role in the world's energy supply. Geothermal has many advantages when compared to traditionally derived fossil fuel energy or even some other types of alternative energy, geothermal can provide energy at a constant rate independent of weather or seasonal considerations.

Geothermal energy can complement other new and renewable energy sources such as hydropower, wind and solar, geothermal development, after the construction of Geothermal Power Plant (GPP) will produce very low or even negligible air emissions.

Indonesia is located on the ring of fire line, this existence makes Indonesia has abundant geothermal resources. Geothermal energy or geothermal is heat that comes from magma in the earth's crust which then heats the fluid trapped far below the surface. This hot fluid often comes to the surface to become hot springs and geysers. However, the fluid that remains below the surface and is not far from its heat source is the source of geothermal.

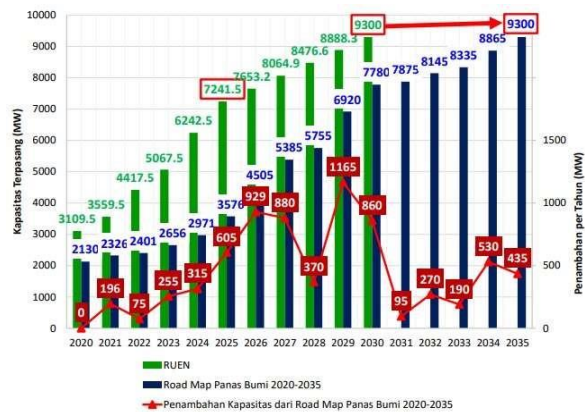


Fig. 4. Geothermal Development Program 2020 – 2035. Source: EBTKE, 2020.

Presidential Regulation Number 22 of 2017 concerning the General Plan for National Energy[16]. The RUEN has stipulated that the utilization of geothermal energy as a power plant is targeted to be 7,200 MW in 2025 and 9,300 MW in 2030. The policy regarding geothermal utilization targets is related to geothermal development in Indonesia. Given that Indonesia has enormous geothermal resources. So that the Government as a policy maker (regulator) must be able to encourage the creation of energy availability, especially EBT, in accordance with the policy direction that has been announced. Geothermal can also be a reliable Renewable Energy to support Energy Security in supporting energy availability in the long term while still paying attention to protection of the environment[17].

Table 3. Availability of Geothermal Power Plants

Plant	Output (MW)	Operation Date	Availability* in 2007 (%)
Otake	13	1967	95.6
Omuma	10	1974	96.2
Hatchobaru #1	55	1977	98.1
Hatchobaru #2	55	1990	95.1
Sumikawa	50	1995	98.6
Yamagawa	30	1995	95.4
Takigami	25	1996	100
Ogiri	30	1996	94.5

* Availability = Operating days / Calendar days

Source: Shijro Saito, 2010

Table 4. Other Data Used for The LCOE Calculation

Data Source	Capacity Factor (%)
PV (Utility)	25%
CSP	32% - 68%
Wind Onshore	35,0%
Wind Offshore	45,0%
Gas CC	85,0%
Gas GT	85,0%
Geothermal	85,0%

Hydro	55,0%
Coal	85,0%
Nuclear	90,0%
Biomass	75,0%

Source: Timilsina, 2020

According to the Government Regulation of the Republic of Indonesia No. 79 of 2014 concerning National Energy Policy, renewable energy sources, which include geothermal, wind, bioenergy, sun, water flow and waterfalls, as well as movement and changes in sea layer temperature, are energy sources that are generated from sustainable energy resources if managed appropriately. The government encourages and strengthens the development of the energy industry in order to accelerate the achievement of energy targets and energy utilization, strengthen the national economy and absorb employment opportunities[18]. Strengthening the development of the energy industry includes increasing domestic capacity to support geothermal exploration activities and electricity support industries.

The utilization of geothermal energy can be divided into two, namely direct and indirect utilization. In direct use, the resulting heat energy is utilized without changing the form of energy, for example, for example, for hot water baths, drying agricultural and plantation products, room heating, and so on. Meanwhile, in indirect utilization, the resulting heat energy is converted into other energy, one of which is as a power plant

3.3. Regulation on Geothermal Energy

Business as Renewable New Energy

Geothermal is one of the renewable energies that has great potential in Indonesia but its installed capacity is still small. Until now, the installed capacity of GPP in Indonesia is only amounting to 2,130.7 MW in 2019 while the potential for geothermal energy resources is 23.9 GW. The Government's commitment to developing geothermal energy is packaged in the form of a national strategic program as outlined in Presidential Decree Number 22 of 2017 concerning the General Plan for National Energy. The government strongly supports the development of environmentally friendly energy, especially geothermal, with a target that the total installed capacity of geothermal energy in 2025 is 7,200 MW [19].

In accordance with Law Number 21 of 2014 concerning Geothermal Energy derived through Government Regulation Number 7 of 2017 concerning Geothermal for Indirect Use, it is explained that the geothermal exploitation process starts from the stage of preparing the work area. The preparation of the working area can come from the preliminary survey and exploration scheme carried out by the Government as well as the Preliminary Survey (PSP) Assignment and the Preliminary Survey and Exploration Assignment (PSPE) carried out by the Business Entity. The next stage is the activity of offering geothermal areas to Business Entities or by assigning geothermal exploitation assignments to State-Owned Enterprises.

The history of determining the Geothermal Working Area (WKP) requires a long historical process, starting with the formation of PT Pertamina (Persero) to the momentum of Law No. 27 of 2003 so that the WKP was divided into two regimes. The Geothermal Working Area (WKP) in Indonesia is basically excluded from two legal regimes, namely the WKP which was formed before Law no. 27 of 2003, and the WKP which was formed after Law no. 27 of 2003. WKP before Law no. 27 of 2003 hereinafter referred to as "Existing WKP", and WKP after Law no. 27 of 2003 hereinafter referred to as the "new WKP". The existing WKP is only owned by PT Pertamina (Persero), while the new WKP and the Geothermal Mining Business Permit (IUP) can be owned by

a legitimate business entity that is the winner of the auction from the WKP auction process, which is furthermore through Law No. 21 of 2014 from IUP changed to Geothermal Permit Regime (IPB).

The regulations in the exploitation of geothermal natural resources include several legislative streams. Law no. 21/2014 on Geothermal Energy is the highest law in the flow of legislation that applies to the exploitation of geothermal natural resources. Broadly discussing, Law no. 21 of 2014 explains that[20]:

- a. Geothermal is a renewable natural resource and is a natural wealth within the territory of the Unitary State of the Republic of Indonesia as a gift from God Almighty which has an important role to support sustainable national development in order to realize people's welfare.
- b. Geothermal energy is environmentally friendly with great potential and its utilization is not optimal, so it needs to be encouraged and increased in a planned and integrated manner in order to reduce dependence on fossil energy.
- c. Whereas in order to maintain the sustainability and security of national energy as well as the efficiency and effectiveness of the implementation of Geothermal for indirect use as a power plant, the Government needs to exercise its implementing authority.
- d. That Law no. 27 of 2003 concerning Geothermal Energy has not regulated the utilization of Geothermal in a comprehensively so it needs to be replaced

4. Conclusion

The supply of oil reserves in Indonesia has decreased every year, this is because the production of Indonesian oil refineries has decreased and the need for fossil energy use has increased significantly every year. From a decrease in the supply of oil reserves, this will affect the condition of the availability of energy supplies, which will cause an event of an energy scarcity condition. The condition of energy scarcity will pose a threat to the country's defense. With the condition that fossil energy reserves will decline and have an impact on energy scarcity, it is time for Indonesia to use new and renewable energy alternatives. Seeing the geographical condition of Indonesia which has the potential for new and renewable energy is very abundant, one of which is new renewable energy in the form of geothermal energy or geothermal energy.

Geothermal energy in Indonesia has GPP installed capacity in Indonesia is only 8.9% 2,130.7 MW of the potential for geothermal energy resources of 2,130.7 MW By looking at the potential of large geothermal sources in Indonesia and geothermal energy that can be relied on as a base load in electricity, it requires a supporting regulation to encourage the exploitation of geothermal energy in Indonesia, which currently ranks second to become the largest geothermal energy producing country in the world.

Acknowledgment

We sincerely thank to the source person for sourcing the data, making the data compatible and persistence also sincerity to arrange this article to be good for publishing. We also thank the anonymous referees for their helpful comments on a previous draft. Nevertheless, we are solely responsible for errors if there are any.

Author Contributions

Mr. (Ph.D. student/Lecturer) performed the statistical analyses, discussed the results, made the concluding remarks, and revised the manuscript. Mr. (Ph.D. student/Lecturer) initiated the idea, reviewed literatures, wrote introduction, data, and methods and revised the manuscript.

References

- F. Anindhita, A. Sugiyono, L. O. Muhammad, and A. Wahid, *Outlook Energi Indonesia 2018: Energi Berkelanjutan untuk Transportasi Darat Book*, no. September. 2018.
- BPPT, *Indonesia Energy Outlook 2019: The Impact of Increased Utilization of New and Renewable Energy on the National Economy*. 2019.
- IESR, "Indonesia Clean Energy Outlook: Tracking Progress and Review of Clean Energy Development in Indonesia," *Jakarta Inst. Essent. Serv. Reform (IESR)*, December 2019, pp. 1–72, 2019.
- H. Nugroho, "Ketahanan Energi Indonesia : Gambaran Permasalahan dan Strategi Memperbaikinya," *Kementeri. PPN/Bappenas*, pp. 2–9, 2014.
- B. Sukadis, "Reformasi di Kementerian Pertahanan RI," *J. Keamanan Nas.*, vol. 2, no. 2, pp. 189–204, 2016.
- R. Azmi and H. Amir, "Ketahanan Energi: Idealitas versus Realitas," *Maj. Info Risiko Fiskal*, vol. Edisi V, no. Maret, 2014.
- BPPT, *Outlook Energi Indonesia 2019 Dampak Peningkatan Pemanfaatan Energi Baru Terbarukan Terhadap Perekonomian Nasional*, no. December. 2019.
- Bappenas, "Di Bangkok, Menteri Bambang Paparkan Komitmen Indonesia Untuk Capai Target Energi Bersih dan Terjangkau Dalam Sdgs," *Bappenas*, 2019. .
- L. J. Moleong, "Metodologi Penelitian Kualitatif," Bandung: Remaja Rosdakarya, 2005.
- Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta, 2018.
- Muhammad AS Hikam, *Ketahanan energi indonesia tantangan dan harapan*, Muhammad A. Jaka: cv. rumah buku, 2015.
- UU Tahun 2019, "UU No 23 Tahun 2019 Tentang Pengelolaan Sumber Daya Nasional Untuk Pertahanan," pp. 1–37, 2019.
- Undang-undang and N. 30, "UU No. 30 Tahun 2007 Tentang Energi," *Int. J. Green Comput.*, vol. 4, no. 1, pp. 83–111, 2007.
- P. 79 K. Energi, "PP Nomor 79 2014.pdf." 2014.
- N. S. Khadijah, "ANALISIS PEMBANGUNAN PEMBANGKIT LISTRIK TENAGA PANAS BUMI (PLTP) MELALUI INSENTIF FISKAL DALAM MENDUKUNG KETAHANAN," *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2013.
- P. N. 22 RUEN, "Presidential Regulation Number 22 of 2017 on the General Planning for National Energy (RUEN)." 2017.
- S. Saito, "Technologies for High Performance and Reliability of Geothermal Power Plant," no. April, pp. 1–4, 2010.
- G. R. Timilsina, "Demystifying the costs of Electricity Generation Technologies," *Demystifying costs Electr. Gener. Technol.*, no. June, 2020.
- Dwinugroho, *Kajian Penyediaan dan Pemanfaatan Migas, Batubara, Ebt dan Listrik*. 2017.
- U. N. 21 Tahun, "UNDANG-UNDANG REPUBLIK INDONESIA NOMOR 21 TAHUN 2014," *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2014.